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Effect of Varying Trace Mineral Supplementation of Steers with or without Hormone Implants on Growth and Carcass Characteristics

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Summary and Implications

The utilization of hormone implants and the supplementation of trace minerals have become well adopted management strategies in the feedlot industry. When hormone implants increase rates of growth in feedlot cattle, this could increase the demand for trace minerals to support those rapid rates of growth. In this study, an aggressive implant strategy dramatically increased growth rates and HCW, without having negative effects on marbling score. It was also observed, regardless of hormone implant, trace mineral supplementation tended to increase overall ADG and steers supplemented at industry consultants recommended concentrations had a 33 lb increase in HCW compared to cattle that received no trace mineral supplementation. This would suggest that hormone implants remain a good return on investment and the current national trace mineral recommendations may not be adequate to support the optimum growth finishing beef steers.

Introduction

Growth rates of feedlot beef cattle have dramatically increased as the result of advancements in genetics and management technologies. Hormone implants are a well adopted management strategy used to increase growth rates and increase hot carcass weight; however, it is unknown what the trace mineral requirements are for rapidly growing beef steers. Therefore, a study was designed to evaluate the concentrations of trace minerals supplemented at national recommendations or commonly supplemented industry concentrations to steers not receiving hormone implants or steers receiving a high-potency implant program. It was hypothesized that greater growth of cattle administered hormone implants requires increased trace mineral supplementation.

Materials and Methods

Seventy-two Angus-cross black hided steers (856 ± 37.8 lbs) were used in a 2 × 3 factorial arrangement. Upon arrival steers were fed a 40% cracked corn, 30% hay, 25% modified distillers grains (MDGS), and 5% supplement diet for 7 days. Steers were transitioned over 21 days to a corn-based finishing diet, described in Table 1. Steers were housed 6 per pen in pens equipped with GrowSafe feeding bunks for individual feed intake determination.

Consecutive-day initial body weights (BW) were collected, and half of the steers were implanted (IMP) with Component TE-IS (Elanco) while half remained non-implanted (NoIMP). Steers began trace mineral supplementation treatments on day 0. Trace mineral treatments included: 1) CON that received no additional trace mineral supplementation, 2) REC that received supplementation at the national recommendations (NAESM, 2016) for Cu (10 mg/kg), Zn (30 mg/kg), Mn (20 mg/kg), Se (0.10 mg/kg), Co (0.15 mg/kg), and I (0.50 mg/kg) from inorganic sources, and 3) IND which received supplementation at the mode value from the Samuelson et al. (2016) feedlot consulting nutritionist survey for Cu (20 mg/kg), Zn (100 mg/kg), Mn (50 mg/kg), Se (0.30 mg/kg), Co (0.20 mg/kg), and I (0.50 mg/kg) from inorganic sources. This resulted in six total treatments with 12 steers per treatment combination.

Interim BW were collected on days 28, 56, 70, 84, 123, and 124. Implanted steers were re-implanted on day 56 with Component TE-200. All steers were shipped to a commercial packing plant (Iowa Premium Beef) on d 124 and were harvested on d 125 and individual carcass data were collected.

Liver biopsies were collected from 3 steers per pen on d -7, 70, and a sample was taken at slaughter (d 125) for trace mineral analysis. Blood samples were also collected on d -1, 70, and 124 for plasma glucose and urea nitrogen concentrations.

Total cost, income, profit, breakeven selling price for variable costs, and breakeven selling price for all costs were collected for steers in this experiment. Budget was utilized from Iowa State University Extension and Outreach Ag Decision Maker File B1-21. All costs were held constant among treatments with only the cost of the hormone implants and mineral supplementation different among treatments.

Data were analyzed as a 2 × 3 factorial using the MIXED procedure of SAS 9.4 (SAS Inst. Inc., Cary, NC). Animals were assigned to treatments using a completely randomized block design. Fixed effects included block, growth stimulating implant (GS), trace mineral supplementation (TM), and GS × TM. The experimental unit for all data was steer (n = 12 per treatment for performance and carcass data except NoIMP/REC where n = 11; for blood and liver data n = 6 for all treatments except IMP/IND where n = 5). Average daily gain, DMI and F:G were summarized by implant period. Liver mineral from d -7 and plasma glucose and PUN from d -1 served as covariates in analysis for respective parameters to all subsequent sampling dates. Data from one steer were not included in the statistical analysis due to poor overall performance (from NoIMP/REC treatment). Data reported are LSMEANS with SEM. Significance was determined at $P \leq 0.05$ and tendencies determined when $0.05 < P \leq 0.10$.

Results

Day 56 BW tended to be ($P = 0.10$) and d 0 - 56 ADG was ($P = 0.05$) affected by the GS × TM interaction, where within implant treatment, BW and ADG for steers receiving REC or IND were greater than CON, all IMP treatments out-performed NoIMP, but TM had no effect within NoIMP steers. Day 0 – 56 DMI and F:G was improved in implanted steers compared with non-implanted steers ($P \leq 0.01$).

Implant effect data are presented in Table 2. There were no GS × TM interactions for d 56 – 124 performance, DMI, overall performance, or carcass-adjusted live animal performance ($P \geq 0.13$). Day 56 – 124 ADG, DMI, final BW, and overall ADG, DMI, and F:G were improved in IMP steers compared with NoIMP steers ($P \leq 0.03$). Carcass-adjusted final BW and ADG in IMP steers were greater than NoIMP steers ($P < 0.01$).

Trace mineral effect data are presented in Table 3. Trace mineral supplementation increased d 56-124 DMI and overall DMI ($P \leq 0.01$) and tended to increase overall live ADG ($P = 0.07$). Steers in the IND treatment had greater final BW than CON steers, with REC being intermediate, while IND had greater carcass adjusted overall ADG than both REC and CON steers ($P < 0.01$).

There were no GS × TM interactions for liver Cu, Zn, Mn, Se, or Co concentrations ($P \geq 0.11$ on d 70 or 124. Steers that did not receive implants had greater liver Cu and Mn concentrations on d 70 ($P \leq 0.05$) and lesser liver Zn concentrations ($P = 0.01$) on d 125, compared with IMP steers. On d 70 steers in the IND treatment had greater liver Cu concentrations than REC and CON ($P < 0.01$). There was a TM effect ($P \leq 0.01$) on d 70 liver Mn and Se where IND steers had greater liver Mn and Se concentrations than CON ($P \leq 0.01$), with REC intermediate. There was also a TM effect ($P = 0.02$) on d 70 for liver Co concentrations where REC steers had greater liver Co concentrations than CON, with IND intermediate. On d 124 IND steers had greater liver Cu concentrations than CON, with REC intermediate ($P < 0.01$). Steers receiving REC had greater liver Zn concentrations than CON with IND being intermediate on d 124. IND and REC had greater liver Mn and Co concentrations than CON on d 124 ($P \leq 0.01$). Steers receiving IND had greater liver Se concentrations than REC and REC steers had greater liver Se than CON steers on d 124 ($P < 0.01$).

Implants increased HCW by 10.5% compared to nonimplanted steers ($P < 0.01$; Figure 1A). Trace mineral supplementation also affected HCW, where IND steers had greater HCW than REC and CON steers (Figure 1B). Remaining carcass data are not shown. There were no GS × TM interactions, or effects of GS or TM for dressing percent, KPH, backfat, or marbling score ($P \geq 0.13$). There was a GS × TM effect ($P = 0.02$) for ribeye area with IMP/CON being greater than IMP/IND, with IMP/REC intermediate; NoIMP had smaller ribeye area, regardless of TM supplementation. There was also a GS × TM effect for yield grade with NoIMP/IND steers having a greater yield grade than IMP/CON with all other treatments intermediate ($P = 0.02$). There was no GS × TM effect on quality grade distribution ($P \geq 0.48$). There was also no effect of GS or TM on quality grade distribution of steers ($P \geq 0.18$).

Hormone implants decreased the breakeven selling price for all cost by \$0.13/pound. Within implanted steers, supplementing IND concentrations of trace minerals decreased the breakeven selling price for all cost by \$0.21/pound compared to CON. Within non-implanted steers, supplementing IND concentrations of trace minerals decreased the breakeven selling price for all cost by \$0.07/pound compared to CON.

Conclusions

In the present study, regardless of implant status, trace mineral supplementation resulted in a growth response and increased HCW. It is important to note that national recommendations are concentrations shown to prevent symptoms of mineral deficiency and should support growth of cattle (NAESM, 2016), but these may not necessarily be the concentrations needed to optimize performance or profit, given the responses observed in this experiment. Especially with the greater than expected implant response in the present study, further research is needed to investigate which mineral(s) have synergistic relationships with cattle growth and what concentrations are needed to optimize growth of feedlot cattle.

Acknowledgments

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Table 1. Ingredient and nutrient composition of control diet.

Item	% of diet dry matter[1]
Ingredient	
Cracked corn	62.0
MDGS[2]	25.0
Bromegrass hay	8.0
DDGS[3]	3.0765
Limestone	1.5
Salt	0.31
Vitamin A & E premix[4]	0.1
Rumensin 90	0.0135
Analyzed composition	
CP, %	15.97
NDF, %	18.02
Ether extract, %	5.62
Sulfur, %	0.33
Analyzed composition[5], mg/kg DM	
Cu	2.0
Fe	53.8
Mn	7.8
Zn	16.8
Se	0.22
Co	0.05

[1] Trace mineral treatments included: CON (no supplemental trace mineral), REC (2016 recommendations of 10 Cu, 30 Zn, 20 Mn, 0.10 Se, 0.15 Co, and 0.50 I; mg/kg), and IND (feedlot consultant recommendations from Samuelson et al. (2016) of 20 Cu, 100 Zn, 50 Mn, 0.30 Se, 0.20 Co, and 0.50 I; mg/kg). Sources of trace mineral included copper sulfate, zinc sulfate, manganese sulfate, calcium iodate, sodium selenite, and cobalt carbonate.

[2] Modified distillers grains with solubles.

[3] Dried distillers grains with solubles.

[4] Premix provided 2,200 IU vitamin A and 25 IU vitamin E/kg diet.

[5] Analyzed mineral values reflect CON diet total.

Table 2. Main effect of implant status on live animal performance of non-implanted or implanted[1] beef steers fed varying concentrations[2] of supplemental trace minerals.

Item	NoIMP n = 36	IMP n = 35	SEM	*P* - value
Live animal performance[3]				
DMI, lb/d				
d 0-56	21.36	22.62	0.345	0.01
d 56 - 124	20.32	24.04	0.353	0.0001
Overall d 0 - 124	20.84	23.33	0.313	0.0001
BW, lb				
d 0	854	856	4.14	0.82
d 124	1231	1359	12.9	0.0001
ADG, lb/d				
d 56 – 124	2.62	3.50	0.122	0.0001
Overall d 0 - 124	2.98	4.04	0.083	0.0001
F:G				
d 0 – 56	6.44	5.02	0.124	0.0001
d 56 - 124	8.14	7.14	0.304	0.03
Overall F:G	7.13	5.85	0.157	0.0001

[1] Growth stimulated implanted steers (IMP) received Component TE-IS (16 mg estradiol + 80 mg TBA) on d 0 and were reimplanted with Component TE-200 (20 mg estradiol + 200 mg TBA) on d 56, while NoIMP received no implants.
[2] Supplemental trace mineral treatments: CON (no additional supplemental trace minerals), NRC (2016 NRC recommendations: 10 Cu, 30 Zn, 20 Mn, 0.10 Se, 0.15 Co, and 0.50 I; mg/kg), and IND (feedlot consultant recommendations from Samuelson et al. (2016) of 20 Cu, 100 Zn, 50 Mn, 0.30 Se, 0.20 Co, and 0.50 I; mg/kg) all from inorganic sources.
[3] No GS × TM; $P \geq 0.13$.

Table 3. Main effect of trace minerals on live animal performance of non-implanted or implanted[1] beef steers fed varying concentrations[2] of supplemental trace minerals.

Item	CON n =24	REC n = 23	IND n = 24	SEM	*P* - value
Live animal performance[3]					
DMI, lb/d					
d 0-56	21.28	22.33	22.36	0.423	0.13
d 56 - 124	20.75[b]	22.58[a]	23.20[a]	0.433	0.0004
Overall d 0 - 124	21.02[b]	22.46[a]	22.78[a]	0.383	0.004
BW, lb					
d 0	857	856	853	5.07	0.79
d 124	1287	1289	1309	15.7	0.56
ADG, lb/d					
d 56 – 124	2.96	3.04	3.18	0.149	0.59
Overall d 0 - 124	3.34	3.51	3.68	0.102	0.07
F:G					
d 0 – 56	5.92	5.80	5.48	0.152	0.12
d 56 - 124	7.44	7.88	7.60	0.372	0.74
Overall F:G	6.58	6.55	6.34	0.192	0.67

[a,b,c] Within rows, means without a common superscript differ ($P \leq 0.05$).
[1] Growth stimulated implanted steers (IMP) received Component TE-IS (16 mg estradiol + 80 mg TBA) on d 0 and were reimplanted with Component TE-200 (20 mg estradiol + 200 mg TBA) on d 56, while NoIMP received no implants.
[2] Supplemental trace mineral treatments: CON (no additional supplemental trace minerals), REC (2016 NASEM recommendations: 10 Cu, 30 Zn, 20 Mn, 0.10 Se, 0.15 Co, and 0.50 I; mg/kg), and IND (feedlot consultant recommendations from Samuelson et al. (2016) of 20 Cu, 100 Zn, 50 Mn, 0.30 Se, 0.20 Co, and 0.50 I; mg/kg). Sources of trace mineral included copper sulfate, zinc sulfate, manganese sulfate, calcium iodate, sodium selenite, and cobalt carbonate.
[3] No GS × TM; $P \geq 0.13$.
[4] Adjusted overall live performance parameters were carcass adjusted with a common 64.66% dress.

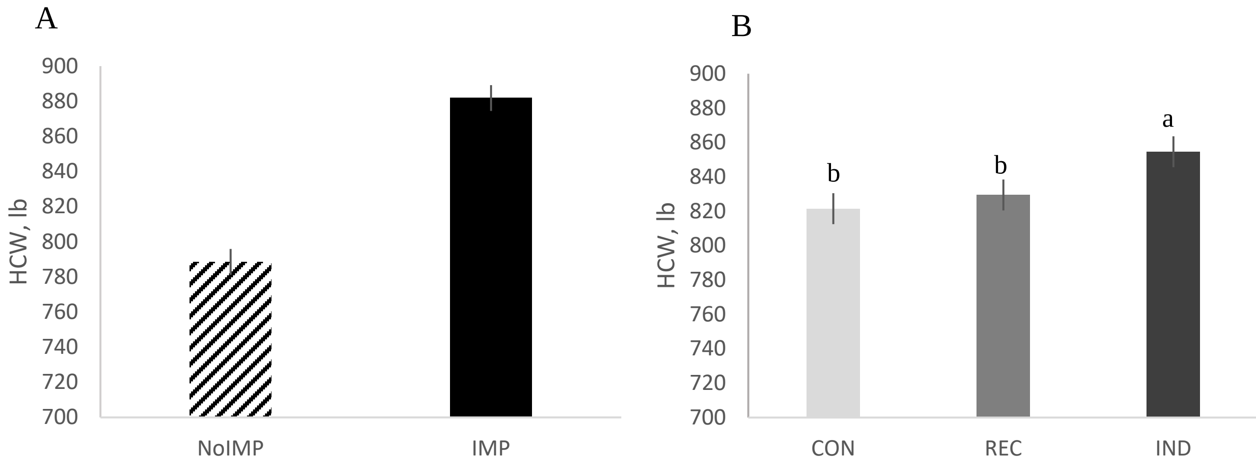

Figure 1. Main effects of implant (panel A; P<0.0001) and trace mineral supplementation (panel B; $P = 0.03$) on HCW of beef steers. [a,b] indicates means differ ($P \leq 0.05$). Growth stimulated implanted steers (IMP) received Component TE-IS (16 mg estradiol + 80 mg TBA) on d 0 and were reimplanted with Component TE-200 (20 mg estradiol + 200 mg TBA) on d 56, while NoIMP steer were not implanted. Supplemental trace mineral treatments: CON (no additional supplemental trace minerals), NRC (2016 NRC recommendations: 10 Cu, 30 Zn, 20 Mn, 0.10 Se, 0.15 Co, and 0.50 I; mg/kg), and IND (feedlot consultant recommendations from Samuelson et al. (2016) of 20 Cu, 100 Zn, 50 Mn, 0.30 Se, 0.20 Co, and 0.50 I; mg/kg) all from inorganic sources.